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FLUID RESISTANCE AND SHIP PROPULSION.

Resistance of Ships and Screw Propulsion. By Naval Constructor D. W. Taylor, U.S.N. Pp. ix+234. New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1907.) Price 10s. net.

A TEXT-BOOK dealing with these subjects, on the basis of scientific principles and experimental investigation, in a form suitable for the use of students, was much required when, fifteen years ago, Naval Constructor Taylor undertook the task. He was exceptionally qualified for the work, having graduated at the Naval Academy at Annapolis, and subsequently passed, with distinction, through the courses of study in naval architecture at the Royal Naval College at Greenwich, where he had the great advantage of attending lectures by Prof. Cotterill, F.R.S., and the instructors in naval architecture. Mr. Taylor's book was largely in the nature of a compilation, and based on work done by British writers, and especially on that of William Froude and Rankine. Due acknowledgment of this indebtedness was made, but the volume also contained much original work. Its presentation of facts and principles was fresh and admirable in form. The style was clear and terse; mathematical investigations were numerous and well arranged; readers were referred to original sources of information; and within two hundred pages a great mass of information was compressed. In these circumstances it was natural that the volume should be widely circulated both in this country and in the United States. It has been out of print for some years, and all interested in these subjects have hoped for a revised edition in which would be embodied work done since 1893 in connection with the resistance and propulsion of ships. The intervening period has been marked by numerous and valuable experimental investigations conducted in tanks which have been established in this country and abroad on the model of that first constructed near Torquay by the late William Froude about forty years ago.

One of the best equipped experimental establishments of this kind is that in the Washington Navy Yard, over which Mr. Taylor has presided, and for the designs of which he was largely responsible. It is much to be regretted, therefore, that the pressure of his official duties should have prevented Mr. Taylor from re-writing his book and bringing it up to date. This is particularly true in regard to the sections of the work which deal with screw-propellers. Mr. Taylor has conducted some of the most important series of experiments on model propellers yet made, and his papers published in the Transactions of the British and American Societies of Naval Architects are both valuable and suggestive. Had it been possible for him to summarise and digest his own results and those obtained by Mr. R. E. Froude, Prof. Durand and other experimentalists, he would have conferred a great service on all who are connected with ship pro-

pulsion. It may be hoped that he will yet attempt this task, for which no living writer on the subject is better qualified.

Taking the book as it stands, as an avowed reprint, it will be welcomed by shipbuilders and marine engineers, who will find therein an excellent epitome of modern theories of resistance and propulsion, and useful illustrations of the applications of these theories in practical ship-designing and the estimate of engine-power required for given speeds. Outside professional circles there are many persons interested in problems of fluid resistance who will be glad to have an exposition of the modern experimental methods which we owe chiefly to the Froudes, and a sketch of the stream-line theory of resistance on which those methods are based.

Thanks to the generosity of Mr. Yarrow, who has himself been responsible for the production of many vessels of exceptional speed and novel type, there is now a practical certainty of the establishment at an early date, in connection with the National Physical Laboratory, of an experimental tank embodying all accumulated experience and having the most modern and perfect equipment. It is true, no doubt, that the results of model experiments can only be applied within certain limits, and that they must be associated with analyses of full-scale trials of ships and propellers. The experience of forty years on the lines laid down by William Froude has established the enormous value of his experimental method in the design and propulsion of steam-ships of novel types and unprecedented speeds. There remains, however, the necessity for more extended research in order that the influence of variations in forms and proportions of ships and the characteristics of screw-propellers may be better understood. Large economies are undoubtedly still possible in the propulsion of steam-ships, and will be realised when systematic model experiments have been carried out by a competent staff, working on lines which have been laid down in conference with practising naval architects and marine engineers.

Herr Wellenkamp proposed recently¹ a method of experimental research on fluid resistance and ship-propulsion which would involve much less expenditure on experimental establishments and their equipment than is needed for tanks on the Froude system. In principle the method is identical with that adopted by Beaufoy in experiments made in this country for the Society for the Improvement of Naval Architecture towards the end of the eighteenth century. The motion of the model through the water is produced by a falling weight. Herr Wellenkamp was not acquainted with Beaufoy's experiments when he devised his apparatus, nor was he aware that other experimentalists—including the Hon. Charles Parsons—had used similar arrangements in recent years. He has worked out the idea in a most ingenious and thorough manner, and used a large tuning-fork as the time recorder, which marks on the revolving sur-

¹ In a paper read at the meetings of the Institution of Naval Architects in April last.

face of a drum intervals of one-hundredth part of a second. He claims to obtain almost absolute uniformity of motion for a sufficient length of run, and accurate records of the corresponding tractive force and velocity of advance during the part of the run when uniform motion occurs. The system is said to have been adopted by the German Admiralty, and in some of the technical institutions of Germany. Its operation and results will be watched with interest; but in the opinion of the writer the new method is not likely to supplant the Froude system, although it may come into use as a supplementary method of making rapid and fairly accurate "first approximations" to resistance. Even minute errors are magnified so greatly in passing from a model to a full-sized ship or propeller that the nearest possible approach to accuracy in the model experiments must be obtained, and this may justify a continuance of the greater expenditure on the experimental tanks and apparatus involved in the Froude system. Experience will decide this matter, and an extended comparison of results obtained on the old system and the new with models of identical form should afford conclusive evidence as to the best course to be followed in future. Experiment alone can be trusted, as no theoretical investigation or mathematical formulæ can deal adequately with the complex conditions of ship-propulsion.

Scientific analysis of the results obtained from systematic series of experiments on the forms of ships and propellers will certainly exercise great influence, and enable designers to proceed with greater certainty in future. There are already many examples of what may be hoped for ultimately in the published papers of Mr. R. E. Froude, Mr. Taylor and others. At present the volume of such information is insufficient, and many departments of knowledge remain obscure. As to methods of analysis, little can or need be said at present; when materials are available suitable methods will be devised. An interesting attempt to deal with the matter in the light of present knowledge will be found in a paper read before the Institution of Naval Architects by Captain Hovgaard, now professor of naval architecture in the Massachusetts Institute of Technology, and responsible for the training of the naval constructors of the United States Navy. Like Mr. Taylor, Captain Hovgaard owes his professional training to the Royal Naval College, Greenwich, and does honour to that institution. His "Analysis of the Resistance of Ships" is worthy of close study, and is based on wide knowledge of the subject. But his conclusion will commend itself to every student. "Not until tanks are established for research work . . . will questions like the present one and many others equally important find their solution." Much may be looked for from the tank at Bushy which Mr. Yarrow has offered to establish, provided shipbuilders, marine engineers and shipowners will guarantee the cost of its maintenance. Such an offer cannot fail to be accepted, and the sooner the work of constructing the tank is begun the better will it be for British shipping.

W. H. WHITE.

LECTURES ON EVOLUTION.

Vorlesungen über Deszendenztheorien mit besonderer Berücksichtigung der botanischen Seite der Frage.
By Prof. J. P. Lotsy. Pp. vi+381-799. Theil ii. (Jena: Gustav Fischer, 1908.) Price 12 marks.

THE second part of Prof. Lotsy's book contains the substance of twenty-eight lectures, completing his course on evolution. Though making no claim to have broken new ground, the work is of real use. The presentation of contemporary knowledge of these subjects which it gives is comprehensive in scope and accurate in treatment. The author does not suffer from the delusion that in evolutionary science finality was reached fifty years ago, and it is a pleasure to see the results of modern research incorporated without ludicrous mistakes. This is probably the best text-book of the subject yet compiled.

There are occasional signs of vacillation between the old and the new conceptions. For example, as an instance of a dissimilarity between reciprocal crosses, Prof. Lotsy brings forward *Bilbergia nutans* × *vittata* on evidence which would have satisfied the older observers. Knowing the sources of ambiguity which affect such evidence, he remarks that possibly the dissimilarity may nevertheless be due merely to "Pleiotypie in F_1 ." Rather, until it shall have been ascertained by repeated experiment that there is consistent dissimilarity between the reciprocals, the presumption is strong that the differences observed are an expression of heterogeneity in the cross-bred generation as such, and are not dependent on the parental rôles allotted to the respective species. The break with tradition which Mendelian discovery has made is, indeed, so wide that a generation must pass before the older interpretations disappear, and evolutionists come to think easily and habitually in terms of the new system. This book will do a good deal towards accelerating the change.

To professed students of genetics this text-book may be recommended as bringing a quantity of fresh materials under consideration which have not previously been dealt with in a consecutive treatise. Of these materials some are ancient and some modern. For the first time, probably, Gärtner's work is presented in summary, and though, judged by modern standards, his experiments are fragmentary and imperfect, many readers will thus become aware of the range of observation which they covered. In another useful chapter a clear abstract of Nägeli's views is provided. Prominence is given to the remarkable experiments of Klebs on *Sempervivum Funkii* showing the influence of external conditions. Facts of this class are extraordinarily difficult to interpret, and until exhaustive work has been done on the same lines we must perhaps abstain from confident interpretation altogether. As a subject for genetic research the *Sempervivums* are most attractive. To turn over Jordan's plates of this polymorphic genus in the "Conspetus"—still more to see his actual collection of living plants now preserved in Miss Willmott's garden—is to realise the great possibilities which the material provides. It is to be hoped that someone will devote himself in good earnest to an analysis of those protean forms.